OccupalionaJ Hygiene. Val. 3. w. 145-152
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A **METHOD FOR COLLECTING WORK HISTORY INFORMATION** IN **OCCUPATIONAL COMMUNIT~i - BASED CASE.CONTROL STUDIES**

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The community-based case-control design is being used increasingly to identify putative disease-caus- ing workplace exposures (Siemiatycki *etal.,* 1985; Gerin and Siemiatycki, 1991). For the purposes of hazard assessment, this design has a number of advantages. First, risks associated with many differ- ent exposures can be explored in the same study. Second, as a surveillance tool, the case-control de- sign can be used to detect risks among workers employed in small workplaces-settings not generally investigated in other study designs. In the United States, for example, 85% of the current workforce is employed in workplaces with fewer than 500 employees (D & B-Dun's Economic Yellow Pages, 1988). Third, in contrast to industry-based studies, data on confounders are relatively easy to obtain. Finally, the risk of disease attributable to a specific exposure can be estimated.

One concern commonly associated with the case-control study is the validity and precision with which the work history is reported and with which exposure is assessed (Siemiatycki *et aL,* 1985; Gerin and Siemiatycki, 1991; Stewart PA and Stewart WF, 1994; Stewart WF and Stewart PA, 1994). In this paper, we describe a new method that addresses some of these concerns and that can be easily applied in case-control studies, regardless of the setting. This method, called SCORE (subject-cor- rected occupational report) (Stewart WF and Stewart PA, 1994), allows the industrial hygienist to first review the work history obtained by an interviewer and then ask follow-up questions about exposure status. We first discuss the limitations to existing methods for collecting work history and exposure information, and then describe the SCORE method.

KEY WORDS: exposure assessment, epidemiology. occupational diseases, questionnaires, case-con- **trol studies**

OBTAINING WORK AND **EXPOSURE mSTORIES: CURRENT APPROACHES**

Traditionally, infonnation about work-related exposures has been obtai... ..case-con- trol studies, directly, indirectly or in a combination of the two. In the direct method, sub- jects or their next-of-kin are asked about exposure to or use of specific chemicals or substances associated with jobs held in the past (e.g. 'Were you ever exposed to ben-

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zene?'). An advantage of this method is that responses to specific questions can be di- rectly analysed. The disadvantage is that while subjects may be able to report use of ma- terials (e.g. paints) or broad classes of chemicals (e.g. pesticides) in the course of their work, they do not usually identify specific chemicals (e.g. perchloroethylene). Moreover, specific chemicals are not likely to be reported with acceptable reliability or validity, because most workers and virtually all next-of-kin are not likely to recognize, recall or even know the names of the specific agents to which the subjects were exposed (Bond *et al.,* 1988; Teschke *et al.,* 1994). As a result, when direct questions are asked, re- spondents may be likely to identify an exposure by mistake (e.g. 'trichloroethylene' for 'trichloroethane') or, more often, underreport an exposure. Another limitation is that

el- evated risk estimates based on such explicit questioning are often attributed to differ- ential reporting between cases and controls. Oirectquestions are likely to be most suitable for workers who are very familiar with the names of materials they use, e.g. names of herbicides used by fanners (Hoar *et al.*, 1986) or type of welding rods used by welders.

An alternati ve to asking specific questions about exposures is to ask open-ended generic questions (e.g. 'What chemicals did you use?'). Answers to this type of question may be more accurate than answers to direct questions on exposure, because subjects are not provided with leading answers. Generic questions may not, however, elicit the informa- tion desired, either because of an inability to freely recall specific chemical names (Blair and Zahm, i 993) or because the chemical names were never known. Generic questions may also be prone to differential recall between cases and controls, because cases may dwell on past exposures more than controls in an effort to explain their disease.

In case-control studies of exposures in the workplace, it is now customary to obtain general information about the work (company, location, job title, start and termination date and possibly tasks and materials used). This information is then used to infer the presence and level of specific agents. The method is highly flexible, in that a number of exposures can be evaluated, including those not anticipated in the planning phase of the study. Also, inferring exposures from reported occupations is likely to be less prone to differential exposure misclassification than asking cases and controls about specific exposures, since respondents are not aware of the investigator' s intentions.

A limitation of this method, however, is that the information reported by the subject is sometimes not adequate for the industrial hygienist to infer exposures (Gerin *et al.*, 1985; Jarvholm *et al.*, 1988), for several reasons. First, the question may have been misunderstood or the answer reported too vaguely or recorded erroneously, partly be- cause study subjects may not have had adequate time or preparation to accurately re- call or report their work history and because they have only one opportunity to recall this history (Williams and Hollan, 1981; Bradburn *et al.*, 1987). Second, work histo- ries are usually obtained by an interviewer who has no training in industrial hygiene or methods of exposure assessment and who has little understanding of workplace en- vironments or exposures. As such, generic questions on work history are asked with little or no probing. When probing questions are asked, they are likely to be asked *ad hoc*, to be incomplete, not necessarily focused on the concerns that the industrial hy- gienist would have and inadequate for the diversity of work environments associated with the reported jobs. Third, the use of generic questions is based on the assumption that the reported industry and job title are adequate to define exposure status and that

there is little or no variability in exposure status (i.e. exposed or not or level of expo- sure) among subjects reporting a similar industry or occupation. This assumption, how- ever, does not always hold. Fourth, the industrial hygienist does not begin to review the data until after the interviewing has been completed, and he or she therefore has no way of resolving questions about exposure status if the information obtained by the in- terViewer was vague or incomplete.

.Recognizing the limitations of the generic work history questionnaire, Siemiatycki and colleagues (Siemiatycki *et al.* , 1985; Gerin and Siemiatycki, 1991) developed meth- ods that allow the industrial hygienist to collect information on work and exposure from cases and controls that is directly relevant to exposure assessment. In their case- control study, hospitalized incident cancer cases and their hospitalized controls were asked about their work. Subsequently, an industrial hygienist reviewed each occupa- tion to decide if additional information was needed to better assess exposures. If a fol- low-up interview was deemed necessary, the interviewer returned to the subject within days of the initial interview. Follow-up questions developed by the industrial hygien- ists addressed tasks, equipment, substances and the work environment related to a spe- cific occupation. For example, welders were asked about the type of metal being welded and whether they were involved in grinding parts or cleaning equipment (Gerin and Siemiatycki, 1991). In contrast to generic questions (e.g. 'What activities did you per- form?'), these questions were highly specific and used terms familiar to those who held the occupation. During this follow-up interview, questions were also asked about the use of specific chemicals; however, the direct questions in this format differed from those noted previously, in that they referred to chemicals in the context of a reported occupation, activity and materials. This feature is likely to improve comprehension of questions and possibly enhance recall on the part of the respondent.

There are other important advantages of the method of Siemiatycki and Gerin over the traditional method. First, an expert in exposure assessment, rather than an inter- viewer, decides whether and which questions are to be asked. The opportunity to ask follow-up questions is analogous to what typically occurs in industry-based studies, where the industrial hygienist can freely explore all aspects of the workplace and of occupations. Thus, any misunderstandings or ambiguities can be immediately resolved, and a more complete understanding of the work environment is provided. This type of questioning is particularly important for identifying possible differences in exposure status for the same occupational title/industry reported by two subjects. Second, in the follow-up interview, the respondent has a second opportunity to recall past events and to clarify what was initially reported. Finally, the information collected is specific to the individual and thereby provides the basis for an individual versus a generic expo- sure assessment.

The approach of Siemiatycki and Gerin improves the validity of exposure assess- ment in comparison with traditional methods (Dewar *et al.*, 1991). SCORE is a mod- ification of their approach, which was developed for use in a community-based case-control study of brain, stomach and oesophageal cancer among Nebraska resi- dents. In this study, respondents were interviewed by telephone about their work his- tory , including job title, industry, start and termination dates, acti vities and materials and equipment used.

SCORE

After an interview was completed in the Nebraska study, a computerized copy of the occupational information reported by each subject was reviewed by an industrial hy- gienist using a computer interface (Figure I). When the industrial hygienist did not clearly understand the exposure environment, follow-up questions specific to the in- dividual' s job were developed. These questions were printed directly onto a form, along with the work history , using a software interface. The SCORE questions focused on factors of interest to the industrial hygienist for the purposes of exposure assessment (Stewart PA and Stewart WF, 1994), including those related to the nature or type of exposure (e.g. source of exposure), the transport of chemicals (e.g. outdoor or indoor work), the job or individual (e.g. level, duration and frequency of exposure, use of per- sonal protective equipment) and the facility.

An effort was made to send the SCORE form to the respondents within eight weeks of the interview. Upon receipt of the form, respondents had the QPportunity to correct errors in their work histories, due both to faulty recall and to errors introduced by the interviewer. The possibility of correcting errors due to recall may be particularly im- portantin the case ofnext-of-kinrespondents (Coggan *etal.,* 1985; Lerchen and Samet, 1986), who may need to refer to records or other sources of information to accurately report the work history of the deceased. The respondents also answered the questions developed by the industrial hygienist.

SCORE offers an inexpensive means for respondents to have a second opportunity to review their work history .This is important, since many cases and controls are el- derly. With little preparation and in a single interview, subjects are often asked to re- port work histories extending over a 4O-50-year period. Under these circumstances, the respondent may find difficulty in recalling past events, because occupations held in the distant past are more likely to be reported erroneously than those held more re- cently (Bond *etal.,* 1988; Bourbonnais *et al.,* 1988; Brisson *et al.,* 1991), and the num- ber of errors is more likely to increase as the number of jobs held increases (Stewart *et al.,* 1987; Bond *et al.,* 1988; Bourbonnais *et al.,* 1988). Studies of autobiographical memory indicate that the number of reporting errors can be diminished by providing subjects with more time to respond (Williams and Hollan, 1981; Bradbum *et al.* , 1987). In part, SCORE is designed to meet this need. In addition, SCORE imposes a minimal burden on the subject and is relatively easy to implement. In an on-going pilot test, over 70% of 191 subjects who were sent the SCORE form responded after an initial mailing and a follow-up reminder letter.

DISCUSSION AND CONCLUSIONS

In this paper, we have reviewed cuITent practices and the limitations of methods for the collection of occupational infonnation from respondents in case-control studies. We have suggested a modification to the method of Siemiatycki and Gerin, which we be- lieve offers a number of additional advantages, including a lower cost of implementa- tion and greater flexibility in adapting the procedures for community-based case-control studies. We also envision that SCORE could be used to identity and locate relevant co-

MAKE CORRECTIONS AND ANSWER QUESTIONS DIRECTLY ON THIS FORM

1st JOB

JOB TITLE	FROM	TO
Remove And Trim Trees	1973	1975
INDUSTRY/BUSINESS TYPE	**NAME AND LOCATION OF BUSINESS**	
Tree Trimming Company	Tree Trimming Company Grand Island, Ne	
USUAL ACTIVITIES	**MATERIALS USED**	
Trimming And Removal Of Trees.	Dk	

PLEASE ANSWER THE FOLLOWING QUESTION(S):

How many hours a week did your son work with a chain saw? ___hours/week

How was the chain saw powered? ___gas ___electric

(a)

Figure 1 Copy of computerized occupational information reported by subjects at interview

2nd JOB

JOB TITLE	FROM / TO
General Worker	1975 / 1979
INDUSTRY/BUSINESS TYPE	**NAME AND LOCATION OF BUSINESS**
Grain Elevator	Turner Grain Company Shelton, Ne
USUAL ACTIVITIES	**MATERIALS USED**
Taking In Grain, Hauling Grain.	Grain And Pesticides.

PLEASE ANSWER THE FOLLOWING QUESTION(S):

How many hours a week did your son load and unload grain? ___hours/week

How many times a week did your son fill the truck tank with fuel? ___times/week (gasoline) ___times/week (diesel)

What was the usual level of grain dust when loading or unloading grain? ___none ___light ___moderate ___heavy

(b)

Figure 1 *Continued*

workers when the next-of-kin is the proxy respondent for a case or control. Even under the best of circumstances, details about the occupation reported by next-of-kin ar(~ likely to be inaccurate or incomplete (Coggan *et al.*, 1985; Lerchen and Samet, 198(»). Co- workers may offer more accurate infonnation about the work environment but ar(~ rarely sought as proxy respondents. The feasibility of using co-workers was recently demon- strated in a nested case-control study of embalmers (Stewart *et al.* , 1992). Co-~lorkers of 87% *(n* = 299) of 344 deceased embalmers were located; of these co-workers, 81 % reported working with the decedents before 1970 (i.e. 20 years or more before the in- terview date) and were able to answer detailed questions about the work environment. A limitation of contacting co-workers is that it can be costly, so that interviews ~Iith co- workers might best be used when occupations are judged by the industrial hygil~nist to involve exposure to the agent(s) of interest. SCORE could be used to selectiv,ely ask next-of-kin respondents for the name and telephone number (or address) ofrele~'antco- workers when exposure to an agent of interest is suspected but is not known for c:ertain. The co-worker could then be asked work-related questions.

We are currently developing a second generation of the SCORE software. The new version will include a library of questions indexed by occupational and industrial code and by exposure. The new addition has several advantages. Questions askecl of re- spondents are standardized. Specific questions are easily accessed. Moreov(~r, new questions can be easily indexed and added to the library. We also plan to evaluate the impact of this method on the exposure assessment process by comparing assessments made with and without the additional SCORE infonnation.

In conclusion, community-based case-control studies often suffer from limited ex- posure infonnation, a licnitation that can affect estimates of disease risk. The Imethod described here offers an inexpensive and efficient way of collecting more detailed in- fonnation than is usually obtained in this type of study. The increase in the quality of the infonnation should improve the exposure assessment and reduce misclassification.

Acknowledgement

This work was funded by the National Cancer Institute.

References

Blair, A. and Zahm, S. H. (1993). Patterns of pesticide use among farmers: implications for epidemi- ologic studies. *Epidemiology*, 4, 55-62.

Bond, G. G., Bodner, K. M., Sobel, W., Shellenberger, R. J. and Aores, G. H. (1988). Validation of work histories obtained from interviews. *Am. J. Epidemiol.*, 128, 343-351.

Bourbonnais, R., Meyer, F. and Theriault, G. (1988). Validity ofself-reported work history.llr. *J. Ind. Med.*, 45, 29-32.

Bradburn, N. M., Rips, L. J. and Shevell, S. K. (1987). Answering autobiographical questions: The impact of memory and inference on surveys. *Science*, 236, 157-161.

Brisson, C., Vezina, M., Bernard, P. M. and Gingras, S. (1991). Validity of occupational histories ob- tained by interview with female workers. *Am. J. Ind. Med.*, 19, 523-530.

Coggan, D., Pippard, E. C. and Acheson, E. D. (1985). Accuracy of occupational histories obtained from wives. *Br. J. Ind. Med.*. 42, 563-564.

D & B-Dun's Electronic Yellow Pages (1988). Parsipanny, NJ. Dialog Information Services, Inc. Dewar, R., Siemiatycki, J. and Gerin, M. (1991). Loss of statistical power associated with the use of

ajob-exposure matrix in occupational case-control studies. *Appl. Occup. Environ. Hyg.* , 6, 51;>8-515.

Gerin, M. and Siemiatycki, J. (1991). The occupational questionnaire in retrospective epidemiologic studies: recent approaches in community based studies. *Appl. Occup. Environ. Hyg.*, 6, 495-501.

Gerin, M., Siemiatycki, J., Kemper, H. and Begin, D. (1985). Obtaining occupational exposure his- tories in epidemiologic case-control studies. *J. Occup. Med.*, 27, 420-426.

Hoar, S. K., Blair, A., Holmes, F. F., Boysen, C. D., Robel, R. J., Hoover, R. and Fraumeni, J. F., Jr (1986). Agricultural herbicide use and risk of lymphoma and soft-tissue sarcoma. *J. Am. Med. Assoc.* , 156, 1141-1147.

Jiirvholm, B., Malker, H., Ericsson, J. and Sallsten, G. (1988). Pleural mesotheliomas and asbestos exposure in the pulp and paper industries: a new risk group identified by linkage of official regis- ters. *Am. J. Ind. Med.*, 13, 561-567.

Lerchen, M. L. and Samet, J. M. (1986). An assessment of the validity of questionnaire responses pro- vided by a surviving spouse. *Am. J. Epidemiol.*, 123, 481-489.

Siemiatycki, J., Day, N. E., Fagry, J. and Cooper, J. A. (1985). Discovering carcinogens in the occu- pational environment: A novel epidemiologic approach. *J. NatL. Cancer. Inst.*, 66, 217-225.

Stewart, P. A. and Stewart, W. F. (1994). Occupational case-control studies: Recommendations for exposure assessment. *Am. J. Ind. Med.*, 26, 313-326.

Stewart, P. A., Henick, R. F., Feigley, C. E., Utterback, D. F., Hornung, R., Mahar, H., Hayes, R., Douthit, D. E. and Blair, A. (1992). Study design for assessing exposures of embalmers for a case- control study. Part I. Monitoring results. *Appl. Occup. Environ. Hyg.*, 7, 532-540.
Stewart, W. F. and Stewart, P. A. (1994). Occupational case-control studies: Collecting information on work histories and work related exposures. *Am.* J. *Ind. Med.* , 26, 297-312.
Stewart, W. F., Tonascia, J. A. and Matanoski, G. M. (1987). The validity of questionnaire-reported work history in live respondents. *J. Occup. Med.*, 29, 795-800.
Teschke, K., Kennedy, S. M. and Olshan, A. F. (1994). Designing questionnaires to report occupa- tional exposures in case-control studies. In: *Conference on Retrospective Assessment of Occupational Exposures in Epidemiology. Programme and Abstracts*, Lyon, International Agency for Research on Cancer, p. 39.
Williams, M. D. and Hollan, J. D. (1981). The process of retrieval from very long-term memory. *Cognit. Sci.*, 5, 87-119.